



Retrospective Study

## Should we resect colorectal cancer in patients over the age of 85?

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**Informed consent statement:**

Patients were not required to give informed consent to the study

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### Abstract

#### BACKGROUND

The prevalence of colorectal cancer in the elderly is rising, with increasing numbers of older patients undergoing surgery. However, there is a paucity of information on the surgical outcomes and operative techniques used in this population.

#### AIM

To evaluate the post-operative outcomes for patients  $\geq 85$  years old following colorectal cancer resection as well as evaluating the outcomes of laparoscopic resection of colorectal cancer in patients over 85.

#### METHODS

Patients who underwent colorectal cancer resection at our institution between January 2010 and December 2018 were included. The study was divided into two parts. For part one, patients were divided into two groups based on age: Those age  $\geq 85$  years old ( $n = 48$ ) and those aged 75-84 years old ( $n = 136$ ). Short term surgical outcomes and clinicopathological features were compared using appropriate parametric and non-parametric testing. For part two, patient's over 85 years old were divided into two groups based upon operative technique: Laparoscopic ( $n = 37$ ) vs open ( $n = 11$ ) colorectal resection. Short-term post-operative outcomes of each approach were assessed.

#### RESULTS

The median length of stay between patients over 85 and those aged 75-85 was

because the analysis used anonymous clinical data that was obtained after each patient agreed to treatment by written consent.

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eight days, with no statistically significant difference between the groups ( $P = 0.29$ ). No significant difference was identified between the older and younger groups with regards to severity of complications ( $P = 0.93$ ), American Society of Anaesthesiologists grading ( $P = 0.43$ ) or 30-d mortality (2% *vs* 2%,  $P = 0.96$ ). Patients over 85 who underwent laparoscopic colorectal resection were compared to those who underwent an open resection. The median length of stay between the groups was similar (8 *vs* 9 d respectively) with no significant difference in length of stay ( $P = 0.18$ ). There was no significant difference in 30-d mortality rates (0% *vs* 9%,  $P = 0.063$ ) or severity of complication grades ( $P = 0.46$ ) between the laparoscopic and open surgical groups.

**CONCLUSION**

No significant short term surgical differences were identified in patients  $\geq 85$  years old when compared to those 75-85 years old. There is no difference in short term surgical outcomes between laparoscopic or open colorectal resections in patients over 85.

**Key Words:** Aged; Colorectal neoplasms; General surgery; Open abdomen techniques; Laparoscopy; Colorectal surgery

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**Core Tip:** This is a retrospective study to assess the outcomes of patients over 85 undergoing colorectal cancer resection. Patients over the age of 85 who underwent surgery were found to have equitable short term surgical outcomes when compared to those aged 75-85 years old. There was no difference in length of stay, severity of complications or mortality rates between the two groups. Patients over 85 were also analyzed based upon outcomes following open or laparoscopic surgery. There were no significant differences between length of stay, complication rates or mortality rates between the two techniques. Surgical intervention for colorectal cancer should not be based upon age alone.

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**INTRODUCTION**

The elderly population is increasing worldwide. In Australia, people over the age of 65 makes up 15% of the population while those aged over 85 make up 2.1% of the population. Colorectal cancer is a leading cause of morbidity and mortality in the western world with incidence rates steadily increasing in the elderly.

Historically, there was an adopted view amongst clinicians that the peri-operative risks were too high for those at the extremes of age, with older patients being offered less aggressive and palliative oncological treatments<sup>[1]</sup>. However, evidence is starting to favour surgical intervention for colorectal cancer in select patients at the extremes of age<sup>[2]</sup>. Previous studies have investigated the outcomes of colorectal resection in different age ranges (over 75's, over 80's *ect.*) and demonstrated favourable results, however there is a paucity of information on the role of colorectal cancer resection specifically in those over 85 (commonly referred to as "the oldest old")<sup>[3]</sup>.

The question of laparoscopic surgery *vs* open surgery in the elderly population has also been explored with several randomised control trials demonstrating favourable outcomes in 'elderly patients'<sup>[4,5]</sup>. Once again, many of these studies focus on patients in the 6<sup>th</sup> and 7<sup>th</sup> decade of life, with a scarcity of studies investigating laparoscopic outcomes in those over 85<sup>[6,7]</sup>.

In order to compare the short-term outcomes from surgery, post-operative complications must be assessed and compared. In previous studies, there has been a



lack of consistency in grading complications. Terms such as ‘mild’, ‘moderate’ and ‘severe’ have been inconsistently used and compared, leading to bias. The Clavien-Dindo classification of post-operative complications has been shown to provide a reproducible and objective classification of post-surgical outcomes. The classification is based upon the severity and required treatment for each complication grade and is graded from grade I-V with Grade V being mortality, the gravest of complications. The classifications have been widely used to standardise outcomes in a variety of surgical subspecialties<sup>[8-10]</sup>.

The aim of this study is two-fold: To investigate the short-term outcomes of patients over the age of 85 undergoing colorectal cancer resection and the use of laparoscopic colorectal cancer resection in those over the age of 85.

## MATERIALS AND METHODS

### **Study design and data source**

A single institution, retrospective study of patients undergoing colorectal cancer surgery at The Prince Charles Hospital.

Patients were divided in two age groups in order to assess the short-term outcomes of patients over 85. The comparison group was chosen to be those between 75-84 years of age. The demographic features, comorbidities, surgical characteristics, short-term outcomes and complications were compared between the two groups.

For the second aim of the study, patients over the age of 85 who underwent laparoscopic colorectal surgery were compared to those who underwent open surgery.

Patient charts were individually reviewed and data extracted by trained medical personnel. Data was obtained from previous admissions, current admissions as well as correspondence letters, follow up documentation and outpatient/readmission notes.

Inclusion criteria included those who underwent surgical resection of biopsy proven colorectal cancer at The Prince Charles Hospital between January 2010 and December 2018. Patients were excluded if they had endoscopic resection of the malignant lesion without surgical intervention.

### **Demographic and comorbidity characteristics**

Basic demographic data including age, gender, date of birth, height, weight, body mass index and American Society of Anaesthesiologists (ASA) grade was documented. Specific pre-operative conditions were grouped into comorbid groups and documented for each patient: Cardiovascular (ischemic heart disease, previous coronary artery bypass grafting, previous percutaneous coronary intervention, pacemaker insertion, defibrillator insertion, previous valve repair, heart failure, cardiomyopathy, hypertension, pulmonary hypertension and atrial fibrillation), respiratory [asthma, chronic obstructive pulmonary disease (COPD), bronchiectasis, cystic fibrosis and obstructive sleep apnoea], metabolic (type I diabetes, type II diabetes and hyperlipidaemia), autoimmune (rheumatoid arthritis, psoriasis, polymyalgia rheumatica, and systemic lupus erythematosus) and renal disease.

### **Surgical and pathological features**

Surgical data included the operation performed, urgency of surgery, operative approach, and length of stay. Pathological data included tumour histopathology, histological grade and TNM stage of disease.

### **Short term post-operative outcomes**

Short term outcomes reviewed included complications, 30-d mortality and length of stay. Complications were Graded from I to V according to the Clavien-Dindo Classification of surgical complications ([Supplementary Table 1](#)). Post-operative complications were defined as those that arose up to 14 d post-operatively.

### **Statistical analysis**

Differences in demographic features, comorbidities and surgical/pathological features between the two complication groups were assessed using *t*-tests, chi squared test and Fisher’s exact tests as appropriate. Statistically significant results were defined as those with *P* value  $\leq 0.05$ . Data was analyzed with Stata v14 software (StataCorp). Statistical analysis and review was undertaken by a biomedical statistician.

### Ethics

Ethics approval for this database was granted by the Prince Charles Hospital Human Research Ethics Committee (Reference: HREC/17/QPCH/295). A waiver of consent was approved to allow access to confidential patient information without consent. Patients were not anonymized prior to data collection. However, patient names and certain other identifying data was not recorded in the database to help guard against confidentiality breaches. Patient data was accessed between January 2018 and June 2019.

## RESULTS

### Patient demographics

From January 2010 to December 2018, five hundred and thirty-three patients underwent colorectal cancer resection at our institution. No patients were excluded from the study. One hundred and thirty-six patients were aged between 75-85 years old at the time of surgery. Forty-eight patients were aged 85 or above at the time of surgery. These two groups were compared with the demographic features of each group outlined in [Table 1](#).

The distribution of ASA grading was similar between the two groups, with no significant difference in distribution or prevalence. Hypertension was the most common cardiac comorbidity in both groups (75-85 age group, 63% *vs* 85+ age group, 71%,  $P = 0.38$ ) with coronary artery bypass grafting being more prevalent within the 75-85 years old group (15% *vs* 11%,  $P = 0.025$ ). There was also a significantly higher proportion of women in the over 85 group (69% *vs* 51%,  $P = 0.043$ ). There was no significant difference between the two groups with regards to distribution of other cardiac comorbidities.

Asthma (15% *vs* 8%,  $P = 0.33$ ), COPD (16% *vs* 8%,  $P = 0.23$ ) and obstructive sleep apnoea (7% *vs* 0%,  $P = 0.066$ ) in both groups were not statistically different. There was no significant difference in metabolic or autoimmune comorbidities between the two groups. Those in the 85+ group had a higher incidence of renal disease (pre-operative eGFR less than 60) compared to those in the 75-85 years old group (25% *vs* 46%,  $P = 0.007$ ).

### Surgical and pathological characteristics

The majority of colorectal cancer resections in both age groups were urgent procedures that occurred within 30 d of diagnosis (75-85 age group, 74% *vs* 85+ age group, 79%,  $P = 0.35$ ). Laparoscopic procedures were more common in both groups (67% *vs* 77%,  $P = 0.50$ ) when compared to open procedures. Both age groups demonstrated a high number of right sided colon cancers (61% *vs* 73%,  $P = 0.24$ ), with no significant difference in cancer locations between the two groups. In keeping with tumour location, the most common surgical procedure in both groups was a right hemicolectomy (59% *vs* 71%,  $P = 0.49$ ). The surgical and pathological features of each group are outlined in [Table 2](#).

For the majority of cases in both groups, histopathological analysis identified adenocarcinoma of no special type (86% *vs* 79%,  $P = 0.46$ ) with a low histological grade of cancer (72% *vs* 72%,  $P = 1.0$ ). There was no significant difference between groups with regards to stage of disease at time of surgery. In both groups, the most common stage of cancer progression at time of surgery was Stage IIa (29% *vs* 23%,  $P = 0.57$ ).

### Complications

Patients within both groups experienced a variety of complications which are outlined in [Table 3](#). The most common complication in both groups was a prolonged ileus (75-85 age group, 17% *vs* 85+ age group, 11%). There was a particularly high number of patients in the 75-85 years old group with cardiac arrhythmias (13% *vs* 5%) when compared to the older group. However, there was a higher percentage of abdominopelvic collections (2% *vs* 8%) and incidences of respiratory failure (3% *vs* 8%) in the over 85's group.

### Short term outcomes

The median length of stay in the 75-85 years age group and the 85+ year age group was the same at 8 d ([Table 4](#)). There was a non-statistically significant increase in the proportion of patients who stayed longer than 14 d in the 85+ year age (29% *vs* 38%,  $P = 0.29$ ). However, the 30-d mortality was the same between both groups (2% *vs* 2%,  $P =$

Table 1 Demographic and comorbidity data on patients from 75-85 years old and those  $\geq 85$  years old

Feature	Number of 75-85 years old patients (% of 75-85 years old patients)	Number of $\geq 85$ years old patients (% of $\geq 85$ years old patients)	Total	P value
Patients	136	48	184	
Gender				
Male	66 (49)	15 (31)	81	0.043
Female	70 (51)	33 (69)	103	
Median BMI	26	25		
Range	15-40	16-40		
< 20	2 (1)	2 (4)	4	0.14
20-24.9	44 (32)	24 (50)	67	
25-29.9	50 (37)	16 (33)	65	
30-39.9	31 (23)	5 (10)	36	
> 40	9 (7)	1 (2)	10	
ASA				
Grade I	4 (3)	1 (2)	5	0.43
Grade II	29 (21)	8 (17)	37	
Grade III	84 (62)	29 (60)	113	
Grade IV	19 (14)	9 (19)	28	
Grade V	0 (0)	1 (2)	1	
Cardiac				
Ischaemic heart disease	34 (25)	16 (34)	50	0.27
Coronary artery bypass graft	20 (15)	5 (11)	25	0.025
Percutaneous coronary intervention	9 (7)	4 (9)	13	0.75
Pacemaker insertion	4 (3)	0 (0)	4	0.57
Cardiac valve replacement	6 (4)	3 (6)	9	0.61
Heart failure (all types)	8 (6)	3 (6)	11	1.0
Cardiomyopathy	6 (4)	3 (6)	9	0.61
AICD insertion	1 (1)	1 (2)	2	0.44
Hypertension	85 (63)	34 (71)	119	0.38
Pulmonary hypertension	3 (2)	0 (0)	3	0.57
Atrial fibrillation	28 (21)	12 (25)	40	0.55
Respiratory				
Asthma	21 (15)	4 (8)	25	0.33
COPD	22 (16)	4 (8)	26	0.23
Bronchiectasis	0 (0)	2 (4)	2	0.017
Cystic fibrosis	0 (0)	0 (0)	0	-
Obstructive sleep apnoea	10 (7)	0 (0)	10	0.066
Metabolic				
Type I Diabetes	0 (0)	0 (0)	0	-
Type II Diabetes	27 (20)	11 (23)	38	0.68
Hyperlipidaemia	52 (38)	21 (44)	73	0.61

Previous cancer	31 (23)	10 (21)	11	0.78
Autoimmune				
Rheumatoid arthritis	1 (1)	1 (2)	2	0.44
Psoriasis	5 (4)	1 (2)	6	0.59
Polymyalgia rheumatica	1 (1)	2 (4)	3	0.11
SLEII	1 (1)	0 (0)	1	0.55
Pre-operative renal function				
eGFR > 90	46 (34)	12 (25)	58	0.007
eGFR 60-89	63 (46)	15 (31)	78	
eGFR 45-59	18 (13)	15 (31)	33	
eGFR 30-44	9 (7)	5 (11)	14	
eGFR 15-29	0 (0)	1 (2)	1	
eGFR < 15	0 (0)	0 (0)	0	
Current smoker (within 12 mo)	7 (5)	1 (2)	8	0.68

BMI: Body mass index; ASA: American Society of Anaesthesiologists Physical Status Classifications; COPD: Chronic obstructive pulmonary disease; AICD: Automated implantable cardiac defibrillator; eGFR: Estimated glomerular filtration rate; SLE: Systemic lupus erythematosus.

0.96). There was also a very similar distribution of post-operative complications between both groups. Thirty seven percent of patients in the 75-85 years old group had no complications which is similar to the thirty-five percent in the over 85's group.

There was a similar incidence of high-grade complications (Clavien-Dindo grade > III) between the two groups (22% *vs* 16%) however this difference was not statistically significant ( $P = 0.93$ ).

### **Open vs laparoscopic surgery in the over 85 group**

Patients over the age of 85 were analyzed as to which surgical approach was used (Table 5). Forty-eight patients over the age of 85 underwent surgical resection. Eleven patients had an open procedure (23%) while thirty-seven had a laparoscopic procedure (77%).

The median length of stay between the open and laparoscopic groups was similar at 9 and 8 d respectively. The percentage of patients whose stay was over 14 d was higher in the open technique group (open group, 55% *vs* laparoscopic group, 32%,  $P = 0.18$ ). The 30-d mortality between the groups was also similar (9% *vs* 0%,  $P = 0.063$ ). Open procedures were more likely to be emergency surgical procedures (6/11, 55% *vs* 3/37, 8%,  $P = 0.002$ ).

There were no major differences in the distribution of the Clavien-Dindo grading or severity of complications between the two groups ( $P = 0.46$ ). High-grade post-operative complications occurred in 9% of open procedures compared to the 6% of laparoscopic procedures.

## **DISCUSSION**

The results of our study demonstrate that there is no significant difference between the short-term surgical outcomes between patients over 85 and those 75-85 years old who undergo colorectal cancer resection in terms of median length of stay, grading of complications and 30-d mortality. The results also indicate that the short-term outcomes from laparoscopic resection in those over 85 are similar to those of open surgery. This study is one of the first studies to utilise the Clavien-Dindo grading of complications for the assessment of short-term outcomes in this demographic.

Takeuchi *et al*<sup>[11]</sup> examined a similar cohort of patients (75-85 years old's *vs* over 85 year old's) and compared the same three short-term outcomes following colorectal cancer surgery. The results stipulated that patients over 85 years old have a significantly higher mortality when compared to those in the 75-84 years old group (24% *vs* 9%,  $P = 0.048$ ). However, there was no significant difference in length of stay or post-operative complications. The paper investigated the prevalence of specific

Table 2 Surgical and pathological data of patients from 75-85 years old and those  $\geq 85$  years old

Feature	Number of 75-85 years old patients (% of 75-85 years old patients)	Number of $\geq 85$ years old patients (% of $\geq 85$ years old patients)	Total	P value
Patients	136	48	184	
Surgical urgency				
Emergency	24 (18)	9 (19)	33	0.35
Urgent	101 (74)	38 (79)	139	
Elective	11 (8)	1 (2)	12	
Location of cancer				
Caecum to transverse colon	83 (61)	35 (73)	118	0.24
Splenic flexure to sigmoid	43 (32)	9 (19)	52	
Rectum/anus	12 (9)	4 (8)	16	
Type of operation				
Left hemicolectomy	8 (6)	1 (2)	9	0.49
Right hemicolectomy	66 (49)	30 (63)	96	
Extended right hemicolectomy	14 (10)	4 (8)	18	
Total colectomy	1 (1)	0 (0)	1	
Subtotal colectomy	3 (2)	1 (2)	4	
High anterior resection	24 (18)	3 (6)	30	
Low anterior resection	5 (4)	3 (6)	8	
Ultralow anterior resection	2 (1)	0 (0)	2	
Hartmann's procedure	6 (4)	4 (8)	10	
Abdominoperineal resection	1 (1)	0 (0)	1	
Appendicectomy	2 (1)	0 (0)	2	
Other	4 (3)	2 (4)	5	
Approach				
Laparoscopic	60 (44)	25 (52)	85	0.50
Laparoscopic assisted	31 (23)	12 (25)	43	
Laparoscopic converted to open	14 (10)	2 (4)	16	
Open (including local excision)	31 (23)	9 (19)	40	
Histological diagnosis				
Adenocarcinoma	117 (86)	38 (79)	155	0.46
Mucinous adenocarcinoma	17 (13)	10 (21)	27	
Other	2 (1)	0 (0)	2	
Histological grade				
Low grade	97 (72)	34 (72)	131	1.0
High grade	37 (28)	13 (28)	50	
No grade	2 (0)	1 (2)	3	
Curability				
Curative	125 (91)	41 (85)	166	0.19
Palliative due to metastases	11 (8)	7 (15)	18	
Disease stage (at time of operation)				
Stage I	19 (14)	11 (23)	30	0.57

Stage IIa	39 (29)	11 (23)	50
Stage IIb	14 (10)	7 (15)	21
Stage IIIa	4 (3)	2 (4)	6
Stage IIIb	29 (22)	6 (13)	35
Stage IIIc	10 (8)	5 (10)	15
Stage IV	19 (14)	6 (13)	25

**Table 3 Complications encountered in patients in the 85+ group when compared to the 75-85 years old group**

Complication	Number of 75-85 years old patients (% of 75-85 years old patients)	Number of ≥ 85 years old patients (% of ≥ 85 years old patients)
<b>Surgical Complications</b>		
Abdominopelvic collection	3 (2)	3 (8)
Anastomotic leak	4 (3)	0
Superficial wound dehiscence	1 (1)	1 (3)
Wound infection	11 (7)	0
Prolonged ileus	26 (17)	4 (11)
Urinary retention	2 (1)	0
Post-operative haemorrhage	1 (1)	0
Anastomotic leak	4 (3)	0
<b>Medical complications</b>		
Deep vein thrombosis	3 (2)	0
Pulmonary embolism	1 (1)	0
Respiratory infection	15 (10)	1 (3)
Ischaemic cardiac event	1 (1)	2 (5)
Cardiac arrhythmia	20 (13)	2 (5)
Cerebrovascular event	1 (1)	1 (3)
Respiratory failure	5 (3)	3 (8)
Renal insult	6 (4)	2 (5)

complications (such as ‘pulmonary complications’ or ‘anastomotic leak’). They demonstrated a higher incidence of pulmonary complications in the 85+ population but no other remarkable differences in complications. This study concluded that the mortality rate was higher for the 85+ population but interestingly our data demonstrates similar post-operative mortality rates between the groups.

The decision to perform a colorectal surgical resection in those over 85 is based on numerous factors including patient preference, disease stage, patient comorbid status and frailty. Although our patients over 85 have a similar comorbid burden to those aged 75-85, this may not reflect a patient’s frailty which can play a large part in determining therapy for a patient. Certain surgical scales of frailty such as the Modified Frailty Index have been shown to predict mortality in general surgical procedures<sup>[12,13]</sup> for patients over 60. Unfortunately, frailty scales are rarely utilized by colorectal surgical teams but can play a large role as a factor in determining whether to offer surgery.

From our research we can conclude that the short-term outcomes from surgery in the over 85 years old’s group are comparable to those who are 75-85 years old. This should serve to support surgical intervention in appropriate patients over 85.

Despite the increasing use of laparoscopic surgery for colorectal cancer resections, there is a paucity of information on its use in patients at the extremes of age. As demonstrated in Table 5, there were no significant differences in the length of stay, 30-day mortality or grading of complications between open and laparoscopic procedures in



**Table 4 Short term surgical outcomes in the 85+ group when compared to those in the 75-85 years old group**

Feature	Number of 75-85 years old patients (% of 75-85 years old patients)	Number of ≥ 85 years old patients (% of ≥ 85 years old patients)	Total	P value
Patients	136	48	184	
Median LOS (d)	8 (IQR = 6)	8 (IQR = 6)		
< 14 d	96 (71)	30 (63)	126	0.29
≥ 14 d	40 (29)	18 (38)	58	
30-d mortality	3 (2)	1 (2)	4	0.96
Clavien-Dindo complication				
No complications	50 (37)	17 (35)	67	0.93
Grade I	13 (10)	5 (11)	18	
Grade II	43 (32)	18 (38)	61	
Grade IIIa	14 (10)	5 (10)	19	
Grade IIIb	4 (3)	1 (2)	5	
Grade IVa	8 (6)	1 (2)	9	
Grade IVb	1 (1)	0 (0)	2	
Grade V	3 (2)	1 (2)	3	

LOS: Length of stay; IQR: Inter-quartile range.

those aged over 85.

There was a significantly higher proportion of open procedures for emergency operations (55% *vs* 8%,  $P = 0.002$ ). This is understandable as the open approach affords ease of access, manoeuvrability and manipulation of distended or friable bowel in the setting of a bowel obstruction or perforation. Decisions on surgical approach are based upon multiple factors including urgency, anatomical considerations, surgeon expertise and personal preference. In general, there is a higher proportion of laparoscopic procedures performed on those aged over 85 at our institution.

These results demonstrate that there is no difference in short term outcomes between a laparoscopic or open approach in those over 85. This conclusion is supported by research from Vallribera Valls *et al*<sup>[14]</sup> who demonstrated that laparoscopic approaches in those over 85 are not associated with an increase in morbidity or length of stay. This is also mirrored by more recent studies of Ueda *et al*<sup>[15]</sup> and Hashida *et al*<sup>[16]</sup>, both of whom have demonstrated laparoscopic surgery in the elderly population to be feasible, safe and have equitable outcomes to those in younger age brackets.

Despite the methodology, there are several limitations to this study. The study is a single-centre study and reflects only the practice and outcomes at our particular institution. It should be noted that patients included within this cohort were those that were deemed appropriate candidates for surgery and accepted treatment. There may have been patients who were too comorbid or frail for surgery who did not proceed with a surgical resection. Subsequently, the results should reflect the outcomes of surgery on those deemed surgical candidates and not purely those diagnosed with colorectal cancer. In order to help limit selection bias in the surgical candidate cohort, future studies could investigate the outcomes of all patients over 85 diagnosed with colorectal cancer to quantify the effect of surgery *vs* conservative management regardless of whether they may be surgical candidates. The role of frailty scores in predicting surgical outcomes is also an area for future research and may be an alternative approach to patient stratification than age alone.

## CONCLUSION

Colorectal cancer resection should be offered to appropriate patients, regardless of age. The short-term outcomes of those over 85 years old are not different to those aged 75-

**Table 5 Short term outcomes in laparoscopic vs open resection of colorectal cancer in those over 85 years old**

Feature	Open procedure	Laparoscopic procedure	Total	P value
Patients	11 (23)	37 (77)	48	
Median LOS (d)	9 (IQR = 6)	8 (IQR = 6)		
< 14 d	5 (45)	25 (68)	30	0.18
≥ 14 d	6 (55)	12 (32)	18	
Gender				
Male	3 (28)	12 (33)	15	1.0
Female	8 (73)	25 (68)	33	
30 d mortality	1 (9)	0 (0)	1	0.063
Surgical urgency				
Emergency	6 (55)	3 (8)	9	0.002
Urgent	5 (45)	33 (90)	38	
Elective	0 (0)	1 (3)	1	
Clavien-Dindo complication				
No complications	4 (37)	13 (35)	17	0.46
Grade I	0 (0)	5 (14)	5	
Grade II	5 (46)	13 (35)	18	
Grade IIIa	1 (9)	4 (10)	5	
Grade IIIb	0 (0)	1 (3)	1	
Grade IVa	0 (0)	1 (3)	1	
Grade IVb	0 (0)	0 (0)	0	
Grade V	1 (9)	0 (0)	1	

LOS: Length of stay; IQR: Inter-quartile range.

85 and demonstrate that age alone should not be a determining factor. Our research also shows that laparoscopic resection of colorectal cancer has equitable short term post-operative outcomes to open resections.

## ARTICLE HIGHLIGHTS

### Research background

The global population is living longer than ever before. As a result of extended life expectancies, the prevalence of colorectal cancer in the elderly is increasing. There is a paucity of information on the role of colorectal cancer surgery in the elderly and the short term surgical outcomes associated with this demographic. There is also very little literature on the role of laparoscopic resection of colorectal cancer in those at the extremes of age.

### Research motivation

This research was undertaken to determine the short-term surgical outcomes in those over 85 following colorectal cancer resection. With the increasing use of laparoscopic colorectal surgery, we also ought to investigate the viability of laparoscopic surgery in the over 85 population.

### Research objectives

The main objectives was to determine whether patients over 85 had equitable outcomes following colorectal cancer surgery to those in a younger age bracket. We also sought to investigate the short term surgical outcomes from laparoscopic surgery

*vs* open surgery in over 85's. This research is important as older patients are at a high risk of having surgery withheld based upon age alone, without clear evidence demonstrating whether age is a determinant of poorer surgical outcomes. Furthermore, this research helps to indicate when open or laparoscopic surgery provides better outcomes in this age group.

### Research methods

Patients who underwent colorectal cancer resection between January 2010 and December 2018 at The Prince Charles Hospital, Brisbane were included in the study. The study was divided into two parts. The first part examined two groups: Those over the age of 85 and those aged 75-84. The short term surgical outcomes were compared between the two groups using parametric and non-parametric tests. The second part of the study investigated the outcomes of patients over 85 who had open surgery *vs* laparoscopic surgery. The short term outcomes of each approach were compared and analyzed.

### Research results

Our research demonstrated that there were no significant differences between the short-term surgical outcomes in those over the age of 85 *vs* those aged 75-85 years old. The average length of stay between the two groups was the same at eight days. There was no significant difference in severity of post-operative complications ( $P = 0.93$ ) or 30-d mortality rates ( $P = 0.96$ ). For patients over 85 who underwent laparoscopic resection, there was no difference in outcomes to those that underwent open resection. Between the laparoscopic and open surgical groups there was no difference in length of stay ( $P = 0.18$ ), severity of post-operative complications ( $P = 0.46$ ) or 30-d mortality rates (0.06).

### Research conclusions

From our research we can conclude that it is safe and effective to surgically resect colorectal cancer in patients over the age of 85. There are no significant differences in post-operative outcomes between the over 85 group and the 75-84 years old group. This leads up to conclude that patients should not have surgery withheld based upon age alone. Furthermore, we demonstrated that laparoscopic surgery has equitable outcomes to open surgery and is a viable option in those over 85 years old.

### Research perspectives

Further studies in this area should investigate the role of frailty scores on surgery outcomes. We have demonstrated that age is no barrier to good surgical outcomes, but the role of frailty scores on post-operative outcomes and surgical candidacy could be explored further.

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